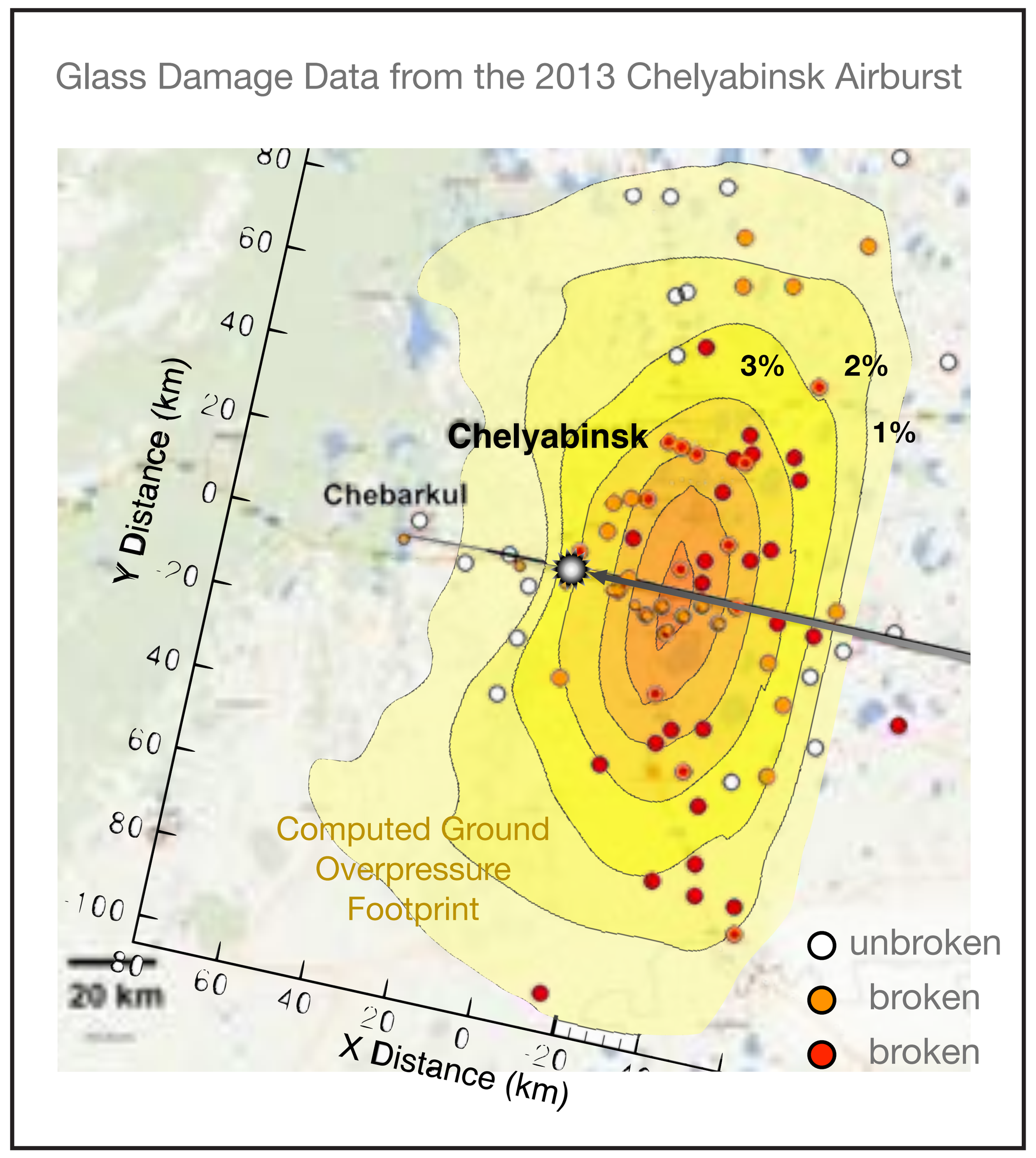
National Aeronautics and Space Administration

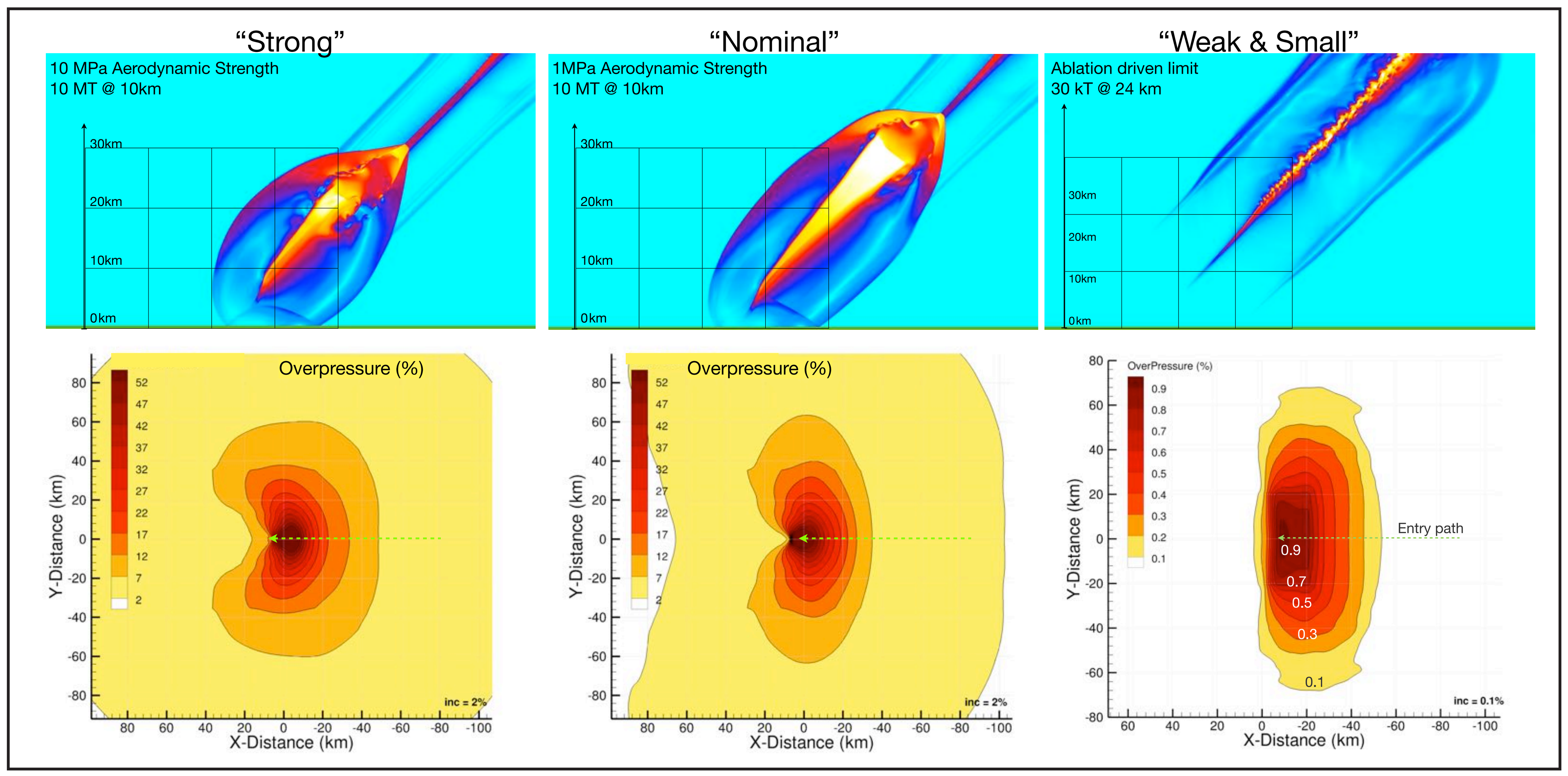
Parametric Studies of Asteroid Impact Scenarios

As meteors decelerate through Earth's atmosphere, they transfer energy into the surrounding air at tremendous rates, producing strong blast waves that may propagate hundreds of kilometers and can cause substantial damage. NASA's Asteroid Threat Assessment Project (ATAP) seeks to quantify the risk from these entries through high-fidelity simulations with the Cart3D software package. Uncertainties in conditions and composition are characterized through large parametric studies of hypothetical cases. Typical simulations use up to 8,000 cores and complete in about one day on the agency's Electra supercomputer. ATAP uses these simulations to create risk models and appraise NASA's Planetary Defense Coordination Office of potential hazards.

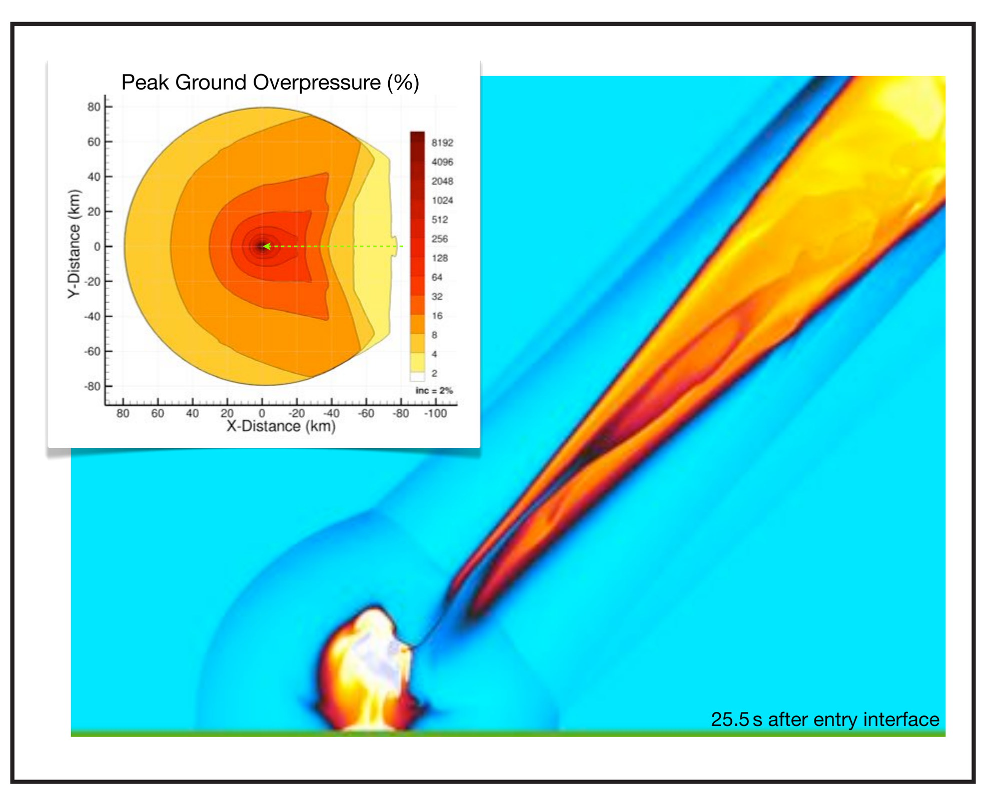
Michael Aftosmis, Marian Nemec, NASA Ames Research Center



This image shows the computed ground overpressure footprint compared with actual blast damage data collected by the Chelyabinsk Airburst Consortium after the 2013 airburst over Chelyabinsk, Russia. Statistical correlations for blast wave data indicate that an overpressure of ~0.7% breaks about 5% of typical glass windows; overpressure of 6% breaks about 90% of windows. The simulations show very good prediction of both the overall footprint shape and strength of the blast from the Chelyabinsk airburst. *Michael Aftosmis, Marian Nemec, NASA/Ames*



Parametric simulations of hypothetical asteroid airbursts of various strengths and sizes. Variation in the ground footprint shapes (bottom row) are due to factors like asteroid size and strength. The entries (top row), shown 30 – 40 seconds after atmospheric impact, are illustrated by contours of local Mach number; the overpressure footprints are given at ground level in percent above ambient pressure. The 30-kiloton entry (at right) roughly corresponds to data collected from the 1994 Marshall Islands Fireball. *Michael Aftosmis, NASA/Ames*



Simulation of a hypothetical asteroid entry that reaches the ground, showing contours of temperature in the symmetry plane. The inset shows the peak overpressures experienced on the ground plane. The entry trajectory is inclined 45° and the asteroid impacts the ground with 100 megatons of kinetic energy. For this simulation, the asteroid composition is assumed to be normal chondrite with a high internal strength, which is more likely to reach the ground than burst in the air. *Michael Aftosmis, NASA/Ames*

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